REMARKS

In view of the above amendments and following remarks, reconsideration and further examination are requested.

Page 30 of the specification has been amended to further describe the invention. No new matter has been added by this amendment. The attached pages showing the changes made to page 30 are captioned ***"Version With Markings To Show Changes Made."***

Also, claims 39, 52 and 58 have been amended, and claims 77-88 have been added to further distinguish the instant invention from the references relied upon by the Examiner for reasons to follow.

The Examiner has rejected claims 39-76 over a plurality of references for a variety of reasons. These rejections are respectfully traversed and the references relied upon by the Examiner are not applicable with regard to the newly amended and added claims for the following reasons.

A main feature of the present invention is that hardening of a solid thermosetting resin (i.e. a thermosetting resin sheet), leveling of bumps, and correcting of warping of a circuit board are achieved at approximately the same time.

According to the present invention, the bonding of an electronic component is executed by hardening with heat a solid thermosetting resin 6 that is interposed between the electronic component 1 and the circuit board 4, while simultaneously performing leveling of bumps 3 and correction of any warping of the circuit board 4 by pressing the electronic component 1 against the circuit board 4 with a force of at least 20 gf per bump. This results in bonding of the electronic component 1 and the circuit board 4 together for electrical connection between the electrodes 2 of the electronic component 1 and the electrodes 5 of the circuit board 4.

That is, when the circuit board 4 is either one of a glass cloth base epoxy copper clad laminate board (glass epoxy board), a glass cloth base polyamide resin copper glad laminate board, or the like, these boards have warp and undulation due to the thermal histeresis, and are not completely planar. When the solid thermosetting resin 6 is provided between the electronic component and the circuit board, the pressing force from one side of the component 1 can be surely transferred to the circuit board 4 via the solid thermosetting resin 6.

Therefore, according to the present invention, as shown in Figs. A1-A3 and C1-C3 attached hereto in Appendix A, though a circuit board 4 is warped with its center portion downwardly projected as shown in Figs. A1 and C1, for example, the warp of the circuit board 4 is corrected and thus an IC chip 1 is surely electrically connected to the circuit board 4 as shown in Figs. A3-A4 and C3-C4. Please note that Figs. A1-A4 show a case where the IC chip 1 is not warped and the circuit board 4 is warped, whereas Figs. C1-C4 show a case where both the IC chip 1 and the circuit board 4 are warped, with the warp of the IC chip being 60 μm, for example.

Specifically, the pressing force from the tool 8 is transferred to the circuit board 4 via the entirety of the solid thermosetting resin 6 (thermosetting resin sheet), which results in uniform pressing of the circuit board 4 for uniformly correcting the warp of the circuit board 4. Therefore, even if the warp of the circuit board 4 is several micrometers, this warp can be surely corrected, whereas if the thermosetting resin is in a liquid form the pressing force cannot be uniformly transferred to the circuit board 4 via the liquid resin. This results in the warp of the circuit board being not corrected or only partially corrected.

This feature is clearly brought in each of independent claims 39, 52 and 58. Specifically, claim 39 recites a method of mounting an electronic component that includes a **solid** thermosetting resin interposed between the electronic component and the circuit board. Similarly, claim 52 also recites a method of mounting an electronic component that uses a **solid** thermosetting resin interposed between the electronic component and the circuit board. And, claim 58 recites an apparatus to mount an electronic component to a circuit board, wherein the apparatus includes a positional alignment device to align bumps on the electrodes of the electronic component with electrodes of the circuit board, with a **solid** thermosetting resin positioned between the electronic component and the circuit board.

Neither Murakami nor any of the other references relied upon by the Examiner teach or suggest a method or apparatus that utilizes a "solid" thermosetting resin to mount an electronic component to a circuit board, while correcting any warping of the circuit board.

In this regard, Murakami discloses that a semiconductor device 105 is pressed under heating to a circuit substrate 101. However, contrary to what is recited in each of the independent claims, the sealing resin 109 is a liquid and **not** a solid. This is so, because the outer configuration of resin 109 is shown to be curved and tightly inserted into recesses as shown in Fig. 3B before any pressing is performed. If the sealing resin were solid, i.e. a sheet, then a gap would be defined between the resin and the circuit substrate, as shown in Figs. 1D and 1E of the present application. Thus, since the sealing resin 109 is liquid, and not solid, a pressing force cannot be sufficiently transferred from the semiconductor device 105 to the circuit substrate 101 via the sealing resin 109. Accordingly, insufficient correction of any warping of the circuit substrate, or no correction at all, will be realized.

Therefore, according to Murakami, as shown in Figs. B1 and D1 attached hereto in Appendix A, were a circuit substrate 4 warped with its center portion downwardly projected the warp of the circuit substrate 4 would not be corrected and thus the IC chip could not be electrically connected to the circuit board 4 as shown in Figs. B2 and D2. Specifically, the distance δ could not be absorbed or eliminated during the pressing operation. Please note that reference character L denotes a liquid sealing resin and LS denotes a hardened sealing resin, and that Figs. B1-B2 show a case where the IC chip 1 is not warped and the circuit board 4 is warped, whereas Figs. D1-D2 show a case where both of the IC chip 1 and the circuit board 4 are warped, with the warp of the IC chip being 60 μm as one example.

Thus, in Murakami, at the onset of pressing, the resin is in a liquid form, and thus, the effects of the present invention in that the hardening of the resin, leveling of the bumps and correcting of any warping of the circuit board can be performed at approximately the same time by pressing the circuit board via the entirety of a solid thermosetting resin sheet, cannot be accomplished.

That is, if the circuit board is warped with its center portion downwardly projected as shown in Figs. B1 and D1, the pressing force cannot be transferred to the center portion of the circuit board and the warpage of the center portion of the circuit board cannot be corrected. Thus, undulation due to thermal histeresis cannot be corrected in Murakami. Therefore, Murakami fails to teach or suggest a method or apparatus that adequately corrects warpage of a circuit board. None of the other references teach or suggest the use of a "solid" thermosetting resin at the onset of pressing, and

accordingly, claims 39-88 are allowable over the references relied upon by the Examiner, either taken alone or in combination.

At this time, Applicant would like to bring to the Examiner's attention the item listed on the Form PTO-1449 provided as part of the Information Disclosure Statement filed concurrently herewith. With reference to Figure 15.48 on page 479 of this item (hereinafter referred to as "Flip Chip"), a process for mounting an electronic component is disclosed. The process consists of three steps. First, nonconductive adhesive is applied to a substrate for the purpose of fixing a chip. Then, gold ball bumps on the chip and the electrodes on the substrate are aligned. And, finally bonding of the chip to the substrate is performed by applying an appropriate load ($\geq$20 kg/cm^2) at a temperature of $\leq$180°C for 15 to 20 seconds. Thus, the chip is electrically connected to the substrate via compressed and deformed gold ball bumps. The pressure at the bond site must be maintained until the chip is fixed by cooling the thermode. Also, "Flip Chip" discloses that the adhesive film consists of an insulating thermosetting/thermoplastic blend adhesive without conductive particles and fillers.

However, like Murakami the nonconductive adhesive is in a liquid state at the onset of the pressing operation. This is so because, if the adhesive were solid, a space would be defined between the adhesive and substrate. Accordingly, because the adhesive is in a liquid form any warping of the substrate would not be adequately corrected for the same reasons that any warping of the substrate of Murakami would not be adequately corrected. Thus, "Flip Chip" in combination with any of the references currently of record would not result in the invention as recited in claims 39-88. Accordingly, claims 39-88 are allowable over "Flip Chip" either taken alone or in combination with any of the other references currently of record.

Furthermore, new claims 77, 80 and 83 recite that any warping of the electronic component is also corrected at the same time as hardening of the thermosetting resin, leveling of the bumps and correcting of any warping of the circuit board. Specifically, since the resin is solid, the pressing force is easily and surely transferred to the circuit board and the electronic component for more effectively correcting the warp of the circuit board and the electronic component. To the contrary, if the resin is liquid, it is difficult to transfer the force to the circuit board and the component. This feature is not

taught or suggested by any of the references relied upon by the Examiner, nor "Flip Chip", and accordingly, each of these claims is patentable in its own right.

Additionally, claims 78, 81 and 84 recite that the heat applied is from 140°C to 230°C and is applied for from several seconds to 20 seconds. Murakami expresses that the temperature of the heating is 270°C and is performed for about 30 seconds. Accordingly, because Murakami does not teach or suggest the limitation as recited in each of claims 78, 81 and 84, each of these claims is patentable in its own right over Murakami either taken alone or in combination with any of the references cited by the Examiner.

And, claims 86-88 recite that the thermosetting resin and circuit board are softened during the hardening of the thermosetting resin by application of heat and while performing the mutual pressing between the electronic component and the circuit board. This softening of the circuit board allows for a better correction of any warping thereof. This feature is not taught or suggested by any of the references of record, including "Flip Chip", and accordingly, claims 86-88 are each patentable in its own right.

Finally. claims 79, 82 and 85 recite specific types of circuit boards that typically have warp and undulation due to thermal histeresis, cutting and processing.

In view of the above amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and an early Notice of Allowance is earnestly solicited.

If after reviewing this Amendment, the Examiner believes that any issues remain which must be resolved before the application can be passed to issue, the Examiner is invited to contact the Applicant's undersigned representative by telephone to resolve such issues.

Respectfully submitted,

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(A) (the circuit board is softened to some extent. This softening aids in the warp of the circuit board being corrected. Also)

internal stress occurring when the IC chip 1 is formed, that is, when a thin film is formed on Si.

In the state in which the warp of the circuit board 4 is corrected, heat of, for example, 140 to 230°C is applied to the thermosetting resin sheet 6 located between the IC chip 1 and the circuit board 4 for about several seconds to 20 seconds, so that this thermosetting resin sheet 6 is hardened. In this stage, the thermosetting resin that constitutes the thermosetting resin sheet 6 flows at the beginning to encapsulate the IC chip 1 up to its edges. The thermosetting resin is naturally softened in the early stage when heated because it is resin, and therefore, the resin gains fluidity to flow up to the edges. By making the thermosetting resin have a volume greater than the volume of a space between the IC chip 1 and the circuit board, the resin flows so as to ooze out of this space, thereby enabling the encapsulating effect to be produced. Subsequently, the heated tool 8 is moved up and the heat source is removed, thus abruptly reducing the temperatures of the IC chip 1 and the thermosetting resin sheet 6. Consequently, the thermosetting resin sheet 6 looses its fluidity, and as shown in Fig. 1G and Fig. 3C, the IC chip 1 is fixed on the circuit board 4 by the hardened thermosetting resin 6s. If the circuit board 4 is heated by the stage 9, then the temperature of the bonding tool 8 can

(because of the composition of the circuit board and the temperature and duration of the heating of the circuit board) (A)

be set lower.

Instead of sticking the thermosetting resin sheet 6, it is acceptable to place a thermosetting adhesive 6b on the circuit board 4 by coating through dispensing or the like or printing or transfer as shown in Fig. 1H. When using the thermosetting adhesive 6b, basically the same processes as the aforementioned processes using the thermosetting resin sheet 6 are executed. When using the thermosetting resin sheet 6, there are the advantage that the sheet 6 is easy to handle because the thermosetting resin sheet 6 is solid, the advantage that the sheet 6 can be formed of polymer because no liquid component exists and the advantage that a sheet having a high glass transition point is easy to be formed. In contrast to this, when using the thermosetting adhesive 6b, the adhesive 6b can be coated, printed, or transferred in an arbitrary position and an arbitrary size on the board 4.

It is also acceptable to use an anisotropic conductive film (ACF) in place of the thermosetting resin, and by further using nickel powders plated with gold as conductive particles to be included in the anisotropic conductive film, the connection resistance value between the electrode 5 and the bump 3 can be reduced, to a further advantage.

The mounting process in the case where the

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39. A method of mounting an electronic component, said method comprising:

aligning in position bumps formed by wire-bonding on electrodes of said electronic component with electrodes of a circuit board, with interposition between said electrode component and said circuit board of insulative solid thermosetting resin;

hardening with heat said thermosetting resin interposed between said electronic component and said circuit board, while achieving mutual pressing between said electronic component and said circuit board at a pressure force of at least 20 gf per bump [, thereby] during [performing] leveling of said bumps and correcting of any warping of said circuit board, [and] thereby bonding said electronic component and said circuit board together to achieve electrical connection between said mutual electrodes thereof; and

said hardening, said leveling and said correcting being achieved at approximately the same time.

52. A method of mounting an electronic component, said method comprising:

aligning in position electrodes of said electronic component with electrodes of a circuit board, with interposition between said electronic component and said circuit board of insulative solid thermosetting resin;

hardening with heat said thermosetting resin interposed between said electronic component and said circuit board, while achieving mutual pressing between said electronic component and said circuit board during [, thereby] correcting of any warping of said circuit board, [and] thereby bonding

said electronic component and said circuit board together to achieve electrical connection between said mutual electrodes thereof;

wherein, prior to said aligning, said thermosetting resin, in the form of a solid thermosetting resin sheet having holes formed at positions corresponding [either to said bumps or] to said electrodes of said circuit board and extending in a direction of extension of said electrodes [bumps], with particles being embedded and electrically continuous in said holes, said particles comprising resin balls having surfaces plated with gold, nickel particles, conductive particles made of silver, silver-palladium or gold, conductive paste, or gold balls, is applied to said electrodes of said circuit board by positional alignment, and said bonding is executed by said hardening said sheet by application of heat thereto while conducting said pressing by forcing said electronic component toward said circuit board; and

wherein each of said particles has a size greater than a thickness of a passivation film to be coated on at least said electrodes of said electronic component and smaller than a thickness of one of said electrodes of said circuit board, and said bonding further is executed by applying ultrasonic vibrations to said electronic component.

58. An apparatus to mount an electronic component to a circuit board,

said apparatus comprising:

a positional alignment device to align in position bumps formed by wire-bonding on electrodes of the electronic component with electrodes of the electronic component and the circuit board of insulative solid thermosetting resin;

a heating device to harden with heat the thermosetting resin interposed between the electronic component and the circuit board; and

a pressing device to achieve mutual pressing between the electronic component and the circuit board at a pressure force of at least 20 gf per bump [,thereby] during [performing] leveling of the board, [and] thereby bonding the electronic component and the circuit board together to achieve electrical connection between the mutual electrodes thereof; and

said heating device and said pressing device achieving the hardening of the thermosetting resin, the leveling of the bumps and the correcting of the warping at approximately the same time.

APPENDIX A

Fig. B1

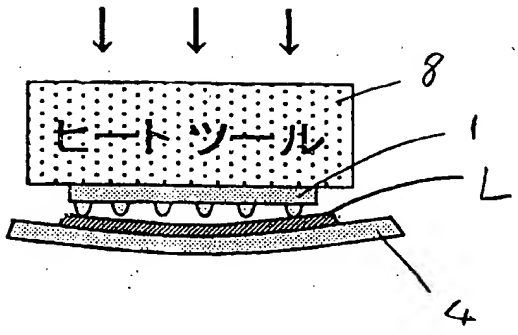

Fig. B2

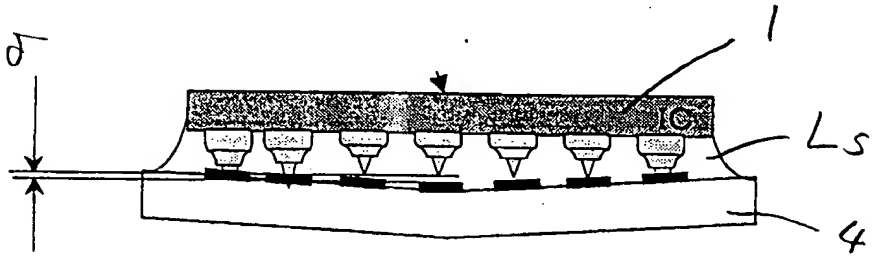

Fig. A4

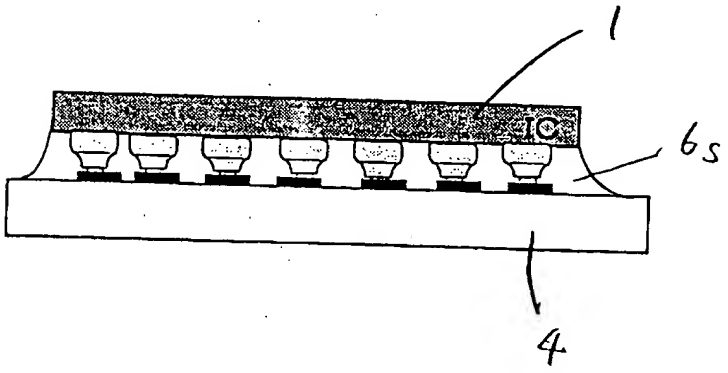

Fig. D1

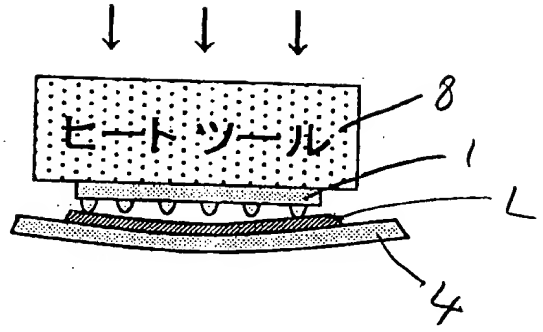

Fig. D2

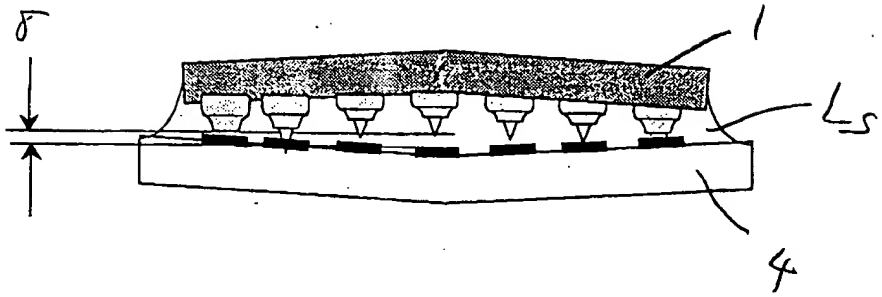

Fig. C4

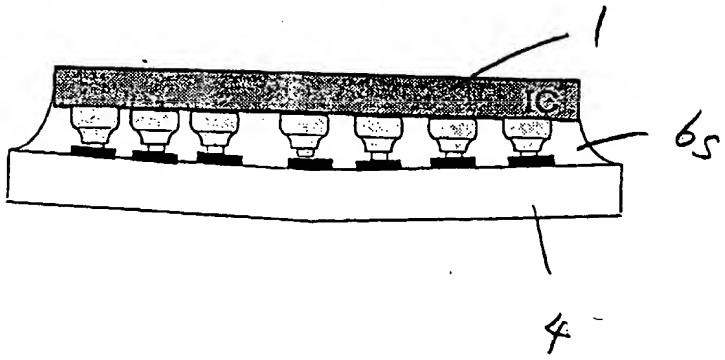

Fig. A1

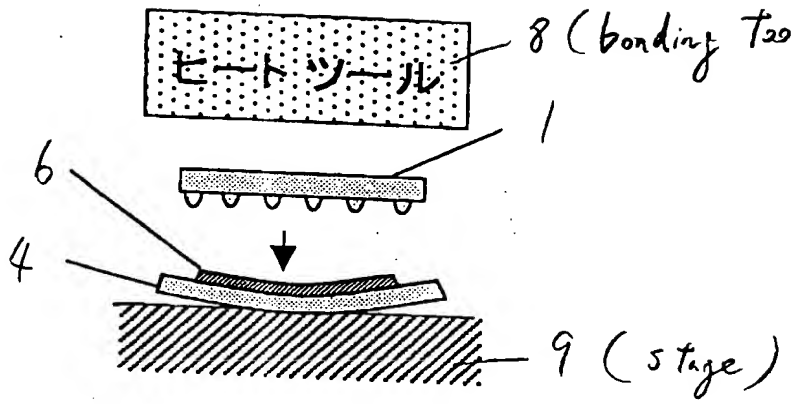

Fig. A2

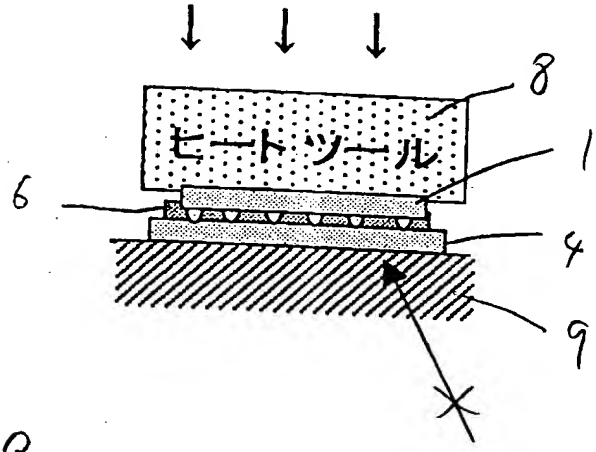

Fig. A3

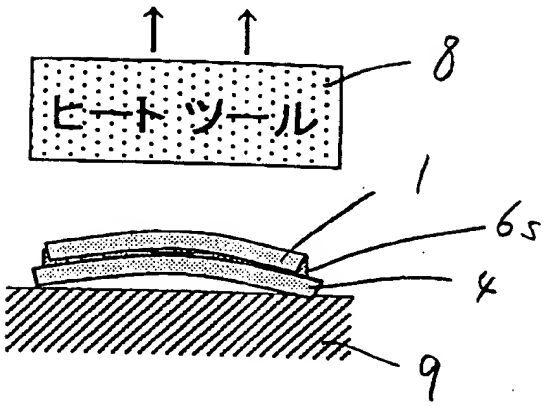

Fig. C1

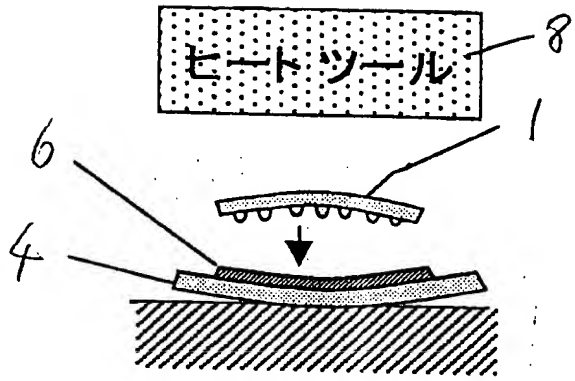

Fig. C2

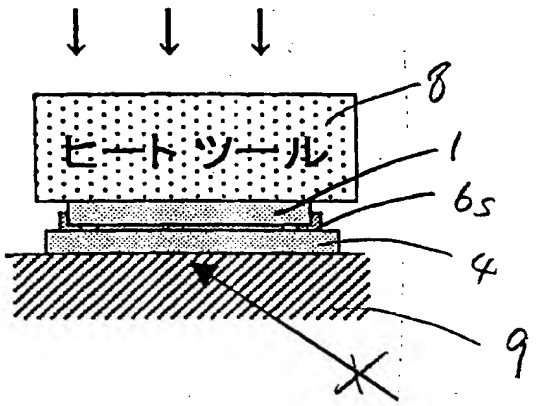

Fig. C3